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COGNITIVE APPRENTICESHIP MODEL WITH GEOGEBRA AND ITS EFFECT ON ACADEMIC ACHIEVEMENT IN GEOMETRY OF ON YEAR EIGHT RURAL SCHOOL STUDENTS

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ABSTRACT

Mathematics plays a significant role in accelerating the social, economic, and technological development of a nation. It is evident in the developing countries, as the nations are rapidly moving towards globalization in all aspects. The world of today tends more profoundly on science and technology demands with additional mathematical knowledge on the part of its people. Thus it is necessary to prepare the child with a strong base of Mathematical knowledge to face the challenges of the modern technological society. This study was conducted to scrutinize the effects of Cognitive Apprenticeship model with GeoGebra and its Effect on Academic Achievement in Geometry of on year eight rural school students. This study was conducted with eighty in two intact classes in Lautoka District in Fiji. The school was selected randomly using the lottery method. After selection the students were classified into two groups one as ICTCAM group and the other as CI group. There were 40 students in each group, and intelligence was kept as Covariate. It was an experimental study of Two by three factorial design was used. The students were also classified into three types of learners according to their standards of learning styles through the LSI Ali.sofia & Dsouza.Flosy (2017).As a pretest, both the groups were tested for Achievement through the ATM prepared by Ali.sofia & Dsouza.Flosy (2017), which was designed according to the Geometry syllabus of year eight. Data was collected, and then treatment was done with 40 lessons of one hour using the instructional package developed by the investigator and validated by experts with the ICTCAM Group, while the CI group was taught with 40 lessons with a duration of 45 mins using the CI instructional Package. The data was collected for the post-test of ATM. The pre and post-test were developed using the new revised Bloom's Taxonomy of Verbs, which had a total of 60 multiple-choice questions. Two way ANCOVA was used for data analysis.

This study proves that there were significant differences in the Achievement in Mathematics of year eight students of rural schools after partialing out the effect of Intelligence. According to the findings of this study, it was recommended that Cognitive Apprenticeship model with GeoGebra supportive teaching methods should be adopted and used in teaching Geometry in year eight level as it develops the high order and low order thinking skills of new revised Bloom's Taxonomy of verbs and improves the Achievement results in Mathematics.

KEYWORDS: LSI –Learning Style Inventory, ATM-Achievement Test in Mathematics, Geogebra, Cognitive Apprenticeship model, Geometry.

INTRODUCTION:

Mathematics is a growing body of concepts and knowledge that makes use of specific language and skills to analyze and interpret the world. It is a powerful means of communication requiring accuracy and precision. Mathematics will provide children and students with opportunities to be creative, discover patterns of numbers and shapes, perceive relationships, represent ideas through models, describe data, and communicate ideas and concepts. It will further develop in children and students the skills, knowledge, and attitudes that will enable them to cope confidently with mathematics in everyday life. Children and students will use the process of problem-solving, logical reasoning, mathematical tools, communication, and estimation. Mathematics is integral to daily living. An activity-oriented method, which values learner involvement and actions of thinking, will be utilized so that Mathematics can be appreciated, appreciated, and enjoyed by everybody. Children and students will develop confidence in their mathematical ability and see mathematics as useful to them and the wider community.

Methodologies for teaching and learning of mathematics have been developing concerning technology. Several dynamic software tools geared towards Mathematics Education provide visually-rich contexts that enable students to comprehend concepts in a meaningful way. Similarly, the National Council of Teachers of Mathematics NCTM (2000) encourages the prominence of the use of multiple representations through technology in cultivating children's Mathematical thinking and reasoning. Low-achievers students are frequently less successful in envisaging mathematical concepts compared to the high achieving classmates. Visual representation of mathematical ideas is much more critical for low-achieving individuals (Moyer-Packenham, Ulmer, and Anderson, 2012).

There exist studies in the literature involving dynamic mathematics software and the Cognitive apprenticeship model for lower secondary in Mathematics education where a substantial increase in student success was observed (Gutierrez and Boero, 2006; Martin-Caraballo and Tenorio-Villalon, 2015).

Geometry is introduced to children in primary school, but it is a topic that is often neglected in Mathematics. Though it has many benefits for children if it is presented in an intuitive, informal manner.

The ultimate aim of teaching geometry is to solve problems and to appreciate the geometry in the world around them because students are prone to generalize the knowledge and experience they learned during the topic of Geometry, which has an entirely different structure than other concepts. The levels of geometric thought (modified van Heile levels by Clements and Battista) in 1992 helps to analyze activities whereby students can recognize and name shapes. There are four levels, as shown in Figure 1, with CAM and Geogebra.

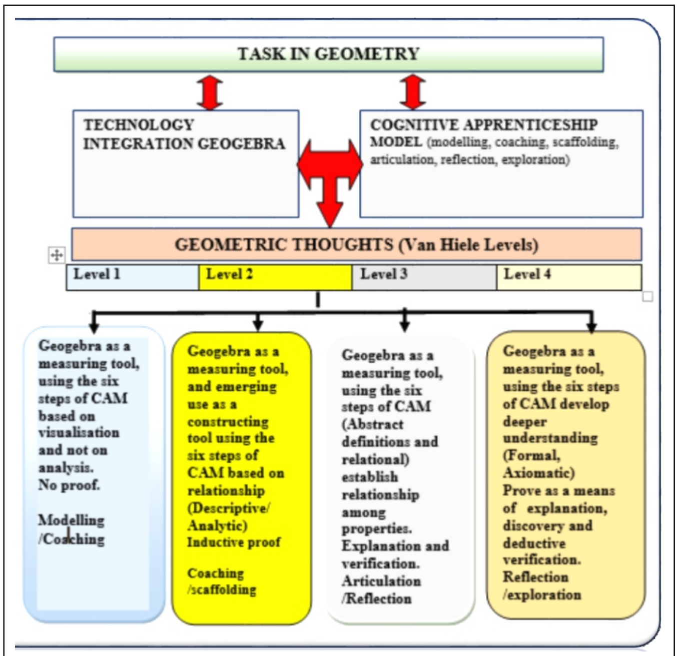

Figure 1: Showing the levels of Geometric thought (modified by van Hiele levels by Clements and Battista, 1992)

Nevertheless, there is a need to develop and utilize DGS for this: "Dynamic geometry environments can (and should) completely transform the teaching and learning of mathematics. Dynamic geometry turns mathematics into a laboratory science rather than the game of mental gymnastics, dominated by computation and symbolic manipulation. As a laboratory science, mathematics becomes an investigation of interesting phenomena, and the role of the mathematics student becomes that of the scientist: observing, recording, manipulating, predicting,

conjecturing and testing, and developing a theory as explanations for the phenomena" (Olive, 2010). This suggests to diminish the role of separate deductive activities and to aim at higher levels by "developing theory as explanations for the phenomena," as proposed by (Olive, 2010). This view is standard by working mathematicians like Whiteley (2000), who stresses the need to bridge the gap between traditional geometry developments and the increasingly refined and widespread applications of geometry in science and day-to-day life, as well as the vital role of DGS: "This overlay of learning tools and research tools is powerful and should be made perceptible in the classroom. The students are not only going through a phase with an educational toy but are learning through a key modern tool of the trade for geometers."

What is GeoGebra?

GeoGebra is a Dynamic Mathematics Software (DMS) for teaching and learning mathematics from middle school through college level. It is as easy to use as Dynamic Geometry Software (DGS) but also provides basic features of Computer Algebra Systems (CAS) to bridge some gaps between geometry, algebra, and calculus. GeoGebra is open source software under the GNU General Public License and freely available at www.geogebra.org. There, you can either download installers for multiple platforms or launch the software directly from the Internet using GeoGebra Web Start.

Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances student's learning. (NCTM, 2000)

GeoGebra was created to help students gain a better understanding of mathematics. You can use it for active and problem-oriented teaching, and it fosters mathematical experiments and discoveries both in the classroom and at home.

History of GeoGebra:

GeoGebra was created by Markus Hohenwarter in 2001/2002 as part of his master's thesis in mathematics education and computer science at the University of Salzburg in Austria. This project was supported by the Austrian Academy of Sciences through his Ph.D. project in mathematics education.

During that time, GeoGebra won several international awards, including the European and German educational software awards, and was translated by math instructors and teachers all over the world to more than 25 languages. Since 2006 GeoGebra is supported by the Austrian Ministry of Education to maintain the free availability of the software for mathematics education at schools and universities. In July 2006, GeoGebra found its way to the US, where its development continues at Florida Atlantic University in the NSF project Standard Mapped Graduate Education and Mentoring.

Cognitive Apprenticeship Model:

Cognitive Apprenticeship is a model developed by Collins Brown and Newman in 1989.

This particular model is relevant to different subjects. According to Collins, Brown, and Newman (1989), Cognitive Apprenticeship emphasizes the solving of real-world problems under expert guidance that fosters Cognitive and Metacognitive skills and processes. To put Cognitive Apprenticeship into practice. Collins et al. (1991) offered six instructional methods of Cognitive Apprenticeship - Modelling, Coaching, Scaffolding, Articulation, Reflection, and Exploration. Based on the innovative work of Tharp (1990) and Tharp and Gallimore (1990) related to assisting in the learning process, Thus for the present study, this model was used with the six different strategies mentioned below in Figure 2.

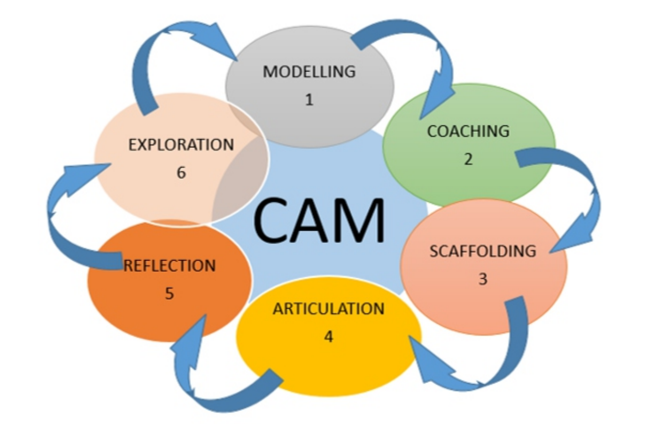

Figure 2: The original six methods of Cognitive Apprenticeship Model in a cyclic model are summarized

However, only a few studies examining the relationship between technologies with CAM while teaching the concept of Geometry, especially in rural primary schools, and there is no study on this topic involving year eight students. Therefore, this research was to observe the effects of GeoGebra with CAM -supported Mathematics Education on year eight primary rural school students' learning through their Achievement in Mathematics.

OBJECTIVES OF THE STUDY:

To study the main and interaction effects of Instructional Strategies (ICT Mediated CAM and Conventional Instruction CI) and Types of Learning Styles (Audio, Visual and Kinesthetic) on Achievement in Mathematics in terms of revised Bloom's Taxonomy of instructional objectives of year eight students of urban schools by taking Intelligence as Co-variate.

THE HYPOTHESIS OF THE STUDY:

H0 (1.0)There is no significant difference in the main and interaction effects of Instructional Strategies (ICT Mediated CAM and Conventional Instruction CI) and Types of Learning Styles(Audio, Visual and Kinesthetic) on the Achievement in Mathematics of year eight students of rural schools by taking Intelligence as Co-variate.

METHODOLOGY:

This study was conducted with 80 students in Lautoka District, rural school. This school was randomly selected using lottery method and students were given a Group Test of Intelligence GGTI.G.C.Ahuja (1971) intelligence test as this was a controlled variable as it would affect the results of the students, and later classified into two groups using their types of learning styles through the LSI Ali, sofia&Dsouza, Flosy (2017) that Audio, Visual and Kinesthetic learners into two groups of ICTCAM and CI.There were 40 students in each group with 10 Audio, 20 Visual and 10 Kinesthetic learners. This research was carried out in the year 2017 academic year with year eight students, which involved an experimental study with 2x3 factorial design. After grouping the students were given pretreatment (pretest) with ATM, and data was recorded regarding their achievement scores. The treatment was done using ICTCAM instructional Package of 40 lessons with a duration of 1 hour and CI group with 40 lessons with 45 minutes duration, which were prepared using the current syllabus of MEHA. The ATM was developed and validated by the experts. A post-test was conducted for both groups. The two sets of scores for pretest and post-test were tabulated. The scores obtained from the tests were analyzed using mean, standard deviation, t-test, and ANCOVA at 0.05 level of significance.

Table 1: Schematic Representation of Two by Three (2x3) Factorial design with Co-variate for rural groups.

	Instructional Strategies(A) / Types of Learning styles (B)	Audio Learners (b_1)	Visual Learners (b_2)	Kinesthetic learners (b_3)
1	ICTMEDIATED CAM (a_1)	a_1, b_1 Y_1, Y_2, Y_3 X	a_1, b_2 Y_1, Y_2, Y_3 X	a_1, b_3 Y_1, Y_2, Y_3 X
2	CONVENTIONAL INSTRUCTION (CI) (a_2)	a_2, b_1 Y_1, Y_2, Y_3 X	a_2, b_2 Y_1, Y_2, Y_3 X	a_2, b_3 Y_1, Y_2, Y_3 X

For the current study, to measure the selected variables of the study, the investigator administered the following tools. As shown in Table 2 below.

Table 2: Showing the details of Evaluation tools used in the study

Tool No	Name of the Tool	Name of the Author of the Tool	Variables
1.	Group Test Of Intelligence (GGTI-A)	G.C.Ahuja (1971) Standardized Test.	Intelligence
2	Learning Style Inventory (LSI-S) Ali, Sofia & D'Souza, and Flosy- (2017) Validated by experts.	Ali, Sofia &D'Souza, Flosy-(2017) Validated by experts.	Types of Learning Style Audio/Visual /Kinesthetic
3	Achievement Test in Mathematics-(ATM-S)	Ali, Sofia &D'Souza, Flosy-(2017) Validated by experts.	Achievement in Mathematics
4	Instructional Material using ICT Mediated CAM	Ali, Sofia &D'Souza, Flosy (2017) validated by subject experts.	Lesson plans and worksheets based on ICTCAM

FINDINGS:

To test the hypothesis, some test statistics are being used. It is imperative to check the assumptions before deciding which statistical test is appropriate. There are two kinds of statistical methods that you can do while testing hypotheses: Parametric and non -parametric. Most parametric tests have two main assumptions that should be met for the test to be accurate. The data collected from the sample should be normally distributed, and the homogeneity of variances should be equal. But non-parametric tests have no such assumptions. Therefore before test-

ing the hypothesis, it was checked the normality of data and homogeneity of variances. Which is displayed in Table 3 ANCOVA Summary of (IS) for ATM for Rural schools (Hypothesis tested at 0.05 level of significance) by taking Intelligence as Covariate.

Descriptive Statistics of Study Group:

Table 3: ANCOVA Summary of (IS) for ATM for Rural schools (Hypothesis tested at 0.05 level of significance) by taking Intelligence as Covariate

COMPONENTS	Source	Type III Sum of Squares	df	Mean Squares	F-ratio	p- ratio	Results
ATM	Instructional Strategies (A)	210.584	1	210.584	47.566	.000	S
	Types of Learning styles (B)	.874	2	.437	.099	.906	NS
	Instructional Strategies (A) x Types of learning styles (B) (A X B)	9.737	2	4.869	1.100	.338	NS
	Error	323.186	73	4.427			
	Total	1011.000	80				

Table 4: Showing the adjusted means of Instructional Strategies for Achievement Test in Mathematics for rural schools

COMPONENT: ACHIEVEMENT IN MATHEMATICS - RURAL SCHOOLS		
GROUP	**Adjusted Mean**	**SD**
ICTCAM	28.05	12.47
CI	19.48	9.357
TOTAL	23.77	10.91

After the experiment, the Achievement Test in Mathematics was conducted into two groups (CTCAM and CI). To test covariate, ANCOVA was used as Intelligence was used as a covariate.

The independent variable was the teaching method, and the dependent variable was the Achievement test in Mathematics, which was administered after the treatment was completed. Intelligence Test scores were used as a covariate in the analysis.

There was a significant effect of Instructional Strategies (ICTCAM and CI) on achievement in Mathematics after controlling for the impact of intelligence. The strength of the relationship between the method and achievement was very significant.

Main Effect on Instructional Strategies:
The instructional Strategies (ICTCAM and CI) differ significantly on the Achievement in Mathematics among year eight students of rural schools after partialing out the effect of intelligence, which reveals that:

- ICTCAM is significantly effective than CI on the Achievement in Mathematics among year eight students of rural schools after partialing out the effect of intelligence.
- The adjusted mean of ICTCAM is higher than the adjusted mean of CI.

Main Effect on Types of Learning Styles:
- There is no significant effect on the Types of Learning Styles (Audio, Visual, and Kinesthetic) of year eight students of rural schools on the Achievement in Mathematics after partialing out the effect of intelligence.

Interaction Effect:
- Interaction of Instructional Strategies (ICT CAM and CI) and Types of Learning Styles (Audio, Visual, and Kinesthetic) has no significant effect on the Achievement in Mathematics among year eight students of rural schools after partialing out the effect of intelligence.

As a result, it can be concluded that Instructional Strategy (ICTCAM) is very effective in teaching Geometry to year eight students as the effect is very significant in the achievement scores of the students in rural schools despite the different learning styles of students. Thus it can be a beneficial strategy that can be adopted to teach the primary school students.

CONCLUSION AND DISCUSSION:
In this study, the effects of using dynamic oriented activities using GeoGebra and Cognitive Apprenticeship model on Achievement with the subject of Geometry in Mathematics were analyzed. Concerning the pretest scores, there was no significant difference in both the groups. Throughout the study, the group that was taught with ICTCAM Achievement scores was increased. Moreover, the post-test results after treatment showed that there was a significant difference between the means of the students' post-test scores in favor of the ICTCAM group. These findings highlighted that students in the ICTCAM group, which used dynamic oriented activities with GeoGebra and CAM, performed better than the Conventional Instruction group.

Hence, it can be considered that using ICTCAM representations can enhance students' understanding of Geometry concept. The similar findings of the studies were found positive on the effects of dynamic oriented activities by using GeoGebra with CAM (Goodwin, 2008; Pitta-Pantazi, Gray, and Christou, 2004; Thambi and Eu, 2013 and Ramatlapana, K. A. (2016). Besides, new standards and documents emphasize the use of multiple representations in the development of Mathematical thinking and reasoning (NCTM, 2000).

Moreover, electronic devices can be used to achieve experiences that in everyday life are either inaccessible or accessible only as a result of time-consuming and often tedious work. Of course, in all these activities, geometry is deeply involved, both to enhance the ability to use technological tools appropriately and to interpret and understand the meaning of the images produced. Computers can also be used to gain a deeper understanding of geometric structures thanks to software designed explicitly for didactical purposes. According to the finding of this study, it was recommended that GeoGebra with CAM (ICTCAM) supporting teaching methods could be used in the year eight classrooms not only to teach Geometry but other four concepts in Mathematics. As a result, this experimental research can promote researchers for further to examine the effectiveness of using ICTCAM strategy with on developing students' learning and understanding of other mathematical concepts apart from Geometry.

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